[redacted]

REPORT ON AIR SAMPLING AT [redacted] STAT

On 8-13-65 the [redacted] Clean Room Complex STAT
[redacted] STAT
STAT was sampled.

25X1 A [redacted] Model 220 electronic particle counter was used for STAT
this air sampling. The [redacted] had been calibrated on 25X1
7-13-65 and was operated by [redacted]

Test Procedures

25X1 The [redacted] Model 220 was programmed to count .5 microns or larger and 5 microns or larger. Each air inlet was sampled for at least ten to fifteen minutes to determine the particulate coming into the room. All of the inlets in each of the four individual rooms were producing air that met Federal Standard 209, Class 100 requirements. The average count taken was approximately 85 particles per cubic foot of air .5 microns or larger.

We hereby certify that all tests were conducted in accordance with Royco Instrument Company prescribed procedures.

THE NEED FOR SECONDARY CONTAMINATION CONTROL IN CLEAN ENVIRONMENTS

by

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Director of Engineering
CRS Industries Inc.

Presented at ASHRAE Chapter Meeting,
Phila.,Pa.

December 10,1964

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Conventional Ultra Clean Room techniques involve the use of pressurization to prevent inward leakage of contamination, high air change rates, i.e. laminar flow, and the use of ultra high efficiency filters in the air conditioning system. The high efficiency filters commonly used have performance ratings in the range of 95 to 99.97 percent efficiency on 0.3 micron DOP smoke. In addition, stringent regulations are used to restrict contamination from traffic, wearing apparel, and employee working habits. While all of these procedures have produced undeniably superior work spaces for miniature precision assembly, and while the value of conventional ultra clean room techniques is borne out by substantial reductions in reject rates, it is also apparent that there is a definite need for a more complete control of the contamination problem within such spaces.

Various studies [1] [2] have clearly shown that airborne particle concentrations in a Clean Room at rest may be increased by a factor of 30 or more with the presence of a few people doing inspecting and packaging work. These "secondary contamination" effects are well known and although they can be kept at a minimum through proper techniques and procedures, these "minimum" conditions can and many times do severely increase the reject rate. The following figures (See Fig.1) illustrate a typical condition [2]. In a system utilizing 60% return air, prefiltering with a fiber filter and an electronic precipitator passed air containing 125,000 particles per cubic foot. Ultra high efficiency final filters reduced this level to 850 particles per cubic foot, while the air within the occupied space contained 25,000 particles per cubic foot. During periods of increased activity in the same space, the combined filtration system delivered air to the room with contamination levels at 4200 particles per cubic foot, while the occupied space contained 55,000 particles per cubic foot! These figures are the total number of particles 0.5 micron in size and larger, and are based on samples taken with a single stage impactor.

10 Not so well known, but recently under study, [2] are contaminant increasing factors related to the mechanical air moving and filtration system. Ultra high efficiency filters, like all mechanical devices, are subject to imperfections and failures such as pin hole leaks, warped frames, and loss of edge sealing. With the high pressure drops used, these tiny leak areas increase filter penetration to relatively large values. Possibly more important than the subsequent loss in efficiency is the fact that these leaks permit large particles to pass into the clean space. Other factors in this category include leakage to or from duct work, reagglomeration of particles downstream of the high efficiency filters, changes and differences in air volume, and humidity effects on the filter media. The ratio of outside air to return air in a system also appears to have a strong effect on room conditions. One would think that extremely low outside air percentages are desirable since this air normally contains much larger concentrations of particulate as well as larger sizes than the return air. However, experience has often shown that the particle concentration in the supply air will more closely follow changes in return air concentration than in outside air concentration. [2]

11 Many of these latter problems are extremely complex and much work will be required before satisfactory solutions are achieved. We are also considerably in the dark in most cases as to the exact mechanisms whereby precision device failures are caused by the various types of particle contaminants. One thing, however, is obvious. The absence of these contaminants in or near the precision device improves conditions. It behooves the Clean Room designer, therefore, to use every method possible which will reduce the particle concentration in the critical area. One such method which extends its influence beyond the scope of the heretofore mentioned procedures is "space charge control of secondary air contamination". [3]

12 Briefly stated, this method acts to greatly reduce the deposition of electrically charged secondary air particles by <u>neutralizing</u> the "space charge" within the room. All aerosols carry some electrical charge, and the various activities in a space, both human and mechanical, invariably produce secondary particles which are charged. By controlling the electrical characteristics of the secondary air, it is possible to control the effects of secondary contaminants which otherwise would do their damage <u>before</u> being drawn by the return air system to the filters.

13 Inasmuch as the real problem lies in the local development of contaminants in the secondary air due to activity of employees, and since a substantial recovery time is needed for the high efficiency filtration action in these circumstances, it would appear that a possible immediate control over such conditions would be such as is offered by the space charge control concept. As pointed out in this concept, [3] the very production of secondary air contaminants causes the development of a space charge. It may start with relatively small intensity, but will gradually increase as the activity continues. The ensuing charged aerosol will then create a space charge in the room which will cause precipitation of particles on surfaces and objects in the space. [4] In order to improve the effectiveness of the high efficiency filtration system, a secondary space charge control system can slow down this space charge precipitation and maintain a larger percentage of these particulates airborne to be subsequently carried back to the filtering system.

It has recently been reported [5] that "relatively high charge densities are associated with particles in the size range of the smaller bacteria and spores, and the ratio of charged to uncharged particles is very high". Related to the space charge concept, the introduction of such charged spores, with related effects of relative humidity and electrostatic deposition on dielectric surfaces, could result in a significant build-up of microorganisms in a typical work area. (See Fig.2) It is evident then, that with respect to sterilization or health requirements, there is again a need for better control of the secondary contaminants.

Aside from the control of all other factors mentioned previously, proper control of clean room facilities is obviously impossible without a high efficiency filtration system. The addition of a <u>secondary</u> control system will almost surely reduce the harmful effects of secondary contamination which cannot be <u>directly</u> coped with by filtration techniques alone.

REFERENCES

(1) Automatic Techniques of Airborne Particle Counting - A. Lieberman, J. Stockham
Air Engineering, December 1960

(2) How To Check Particle Contamination In Ductwork - J. Stockham
Air Engineering, March 1964

(3) Space Charge Control of Secondary Air Contamination Problems - M.H. Pelosi, Jr.
Contamination Control, October 1963

(4) The Starting Point For Contamination Control - K.T. Whitby
AACC Pub. 63-17, 1963

(5) Compatability of Sterilization and Contamination Control With Application To Spacecraft Assembly - R.P. Ernst, A.P. Kretz, Jr.
Contamination Control, November 1964

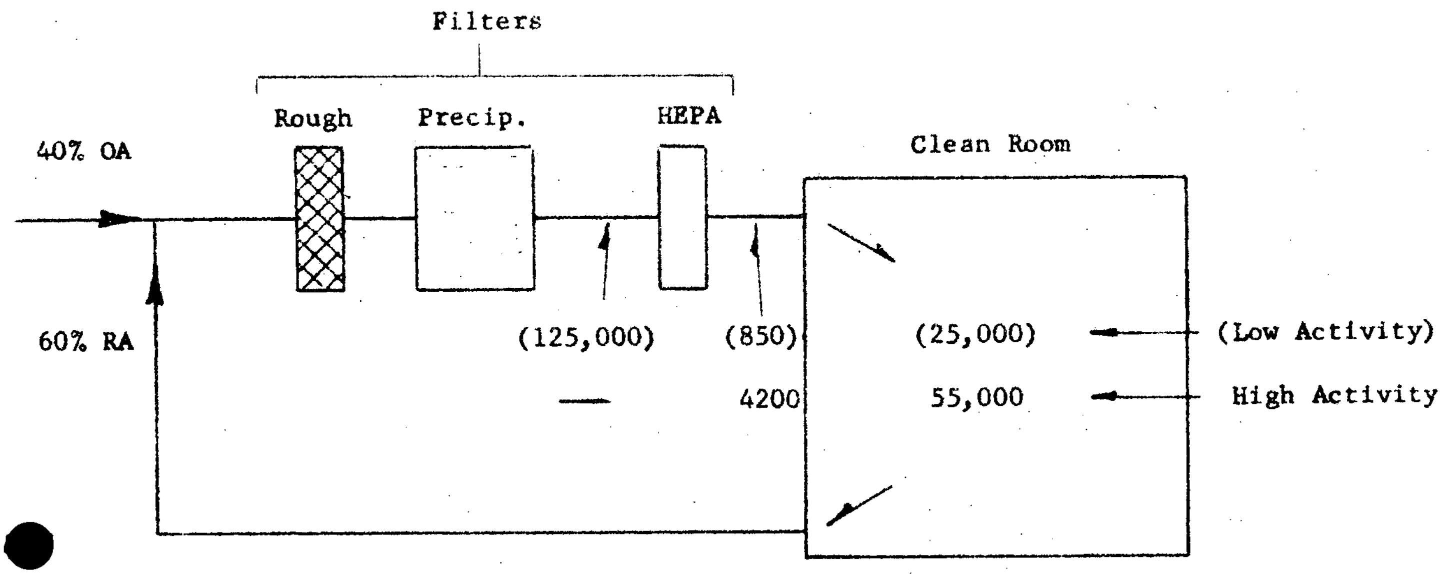

Fig. 1 - Particle Count per cu.ft. 0.5 u and larger

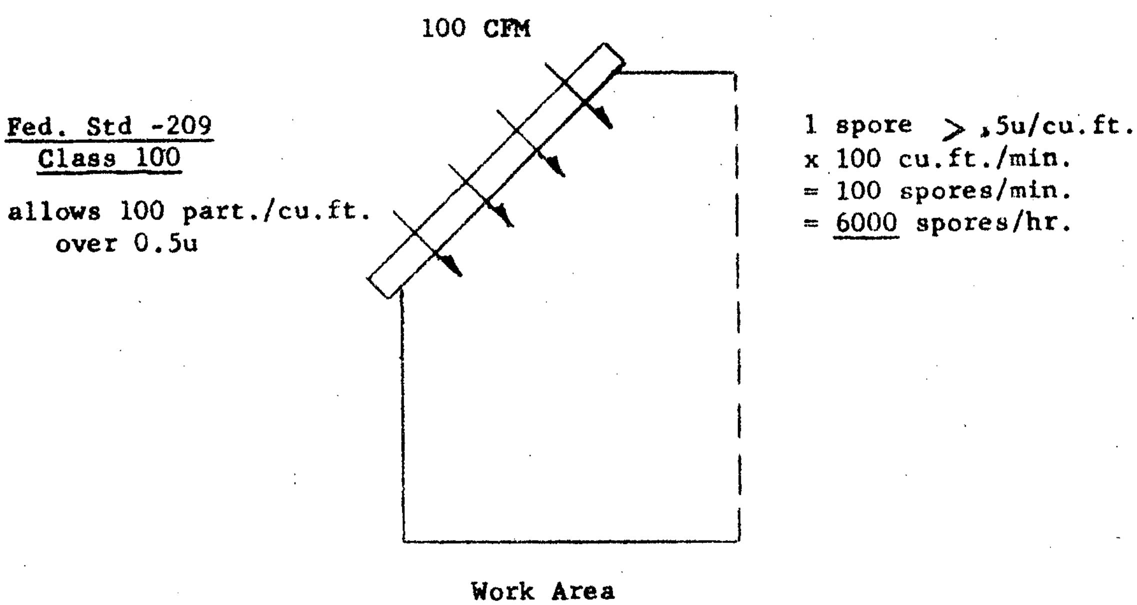

Fig.2 - Possible Microorganism Build-up

File 997604

PROCESSOR RESEARCH PROGRAM

ASSIGNMENT NO.	STAT
DATE	4 Dec. 1964
PRIORITY	1
ISSUED BY	STAT

DESCRIPTION: To evaluate requirements of a clean room type L.A.B. Module

STAT SUPERVISING ENGINEER:

STAFF: As required

OBJECTIVE: To evaluate the design and construction requirements of a L.A.B Processor Module designed specifiaally for clean room use. The module is to be complete with liquid bearings, temperature control, pumps, etc.

PROPOSED METHOD The tank is to be of double wall construction and is to incorporate temperature control. The tank and mountings for liquid bearings are to be "clean." The bearings should be mounted without the necessity of removing panels in the walls of the tank. The pumps and filters must be easily removable without employment of hose connections. Either air bearings or vacuum capstans must be able to be interchanged. The outside must be free of piping or equipment and should present as far as possible an unbroken appearance.

See attached sketch.

BRIEFING COMMENTS

Basic design parameters for the purpose of preliminary concept considerations are as follows:

Solution Temperature - 88°F
Processing Time - 2 minutes
Design Processing Speed - 20 FPM

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PROGRAM

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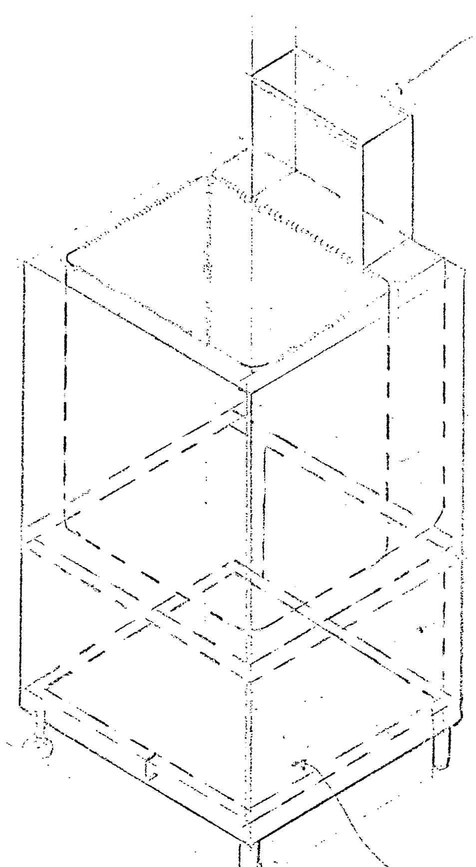
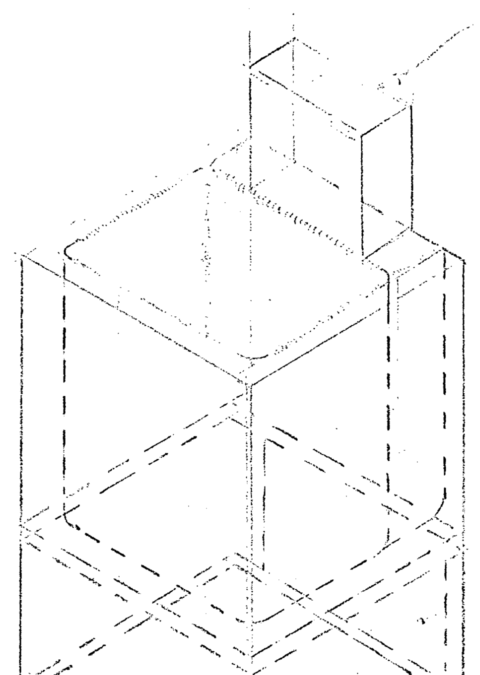


STAT [redacted]



ASSIGNMENT NO.	
DATE:	9 Dec. 1964
PRIORITY	1
ISSUED BY	

PROCESSOR RESEARCH PROGRAM

DESCRIPTION:	To design and test an inter-tank air bearings for 9½" film
SUPERVISING ENGINEER:	
STAFF:	
OBJECTIVE:	To determine and evaluate the performance of an air bearing for 9½ inch film based on the super levitron principle.

PROPOSED METHOD

Make plastic model to sketch provided, mount on blower test stand. Measure air pressures and flows whilst supporting range of weights on 9½" film apron. Check for stability of film and retention of cushion. Pay particular attention to spray released by wetting film during test. Determine most efficient method of supplying air to support cushion.

BRIEFING COMMENTS

Test should include tracing of turbulent and flow patterns by means of filament or smoke streamers. These could be photographed if model were made of transparent plastic. Can film be moved through bearing by same streams which support it? Can provision be made for various film widths?

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ASSIGNMENT NO.		STAT
	10 Dec. 1964	
PRIORITY	1	
ISSUED BY		STAT

PROCESSOR RESEARCH PROGRAM

DESCRIPTION:	To calculate the effeciency of a tank with incorporated thermal control.
SUPERVISING ENGINEER: STAT	
STAFF:	
OBJECTIVE:	To evaluate the performance of a processing tank in which is

immersed as a part of the tank, a means of controlling temperature. The liquid bearings pump is to be considered for recirculation.

PROPOSED METHOD

See attached sketches.

BRIEFING COMMENTS

SUMMARY

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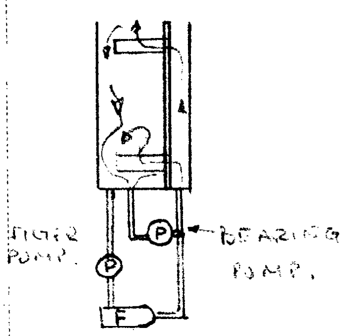

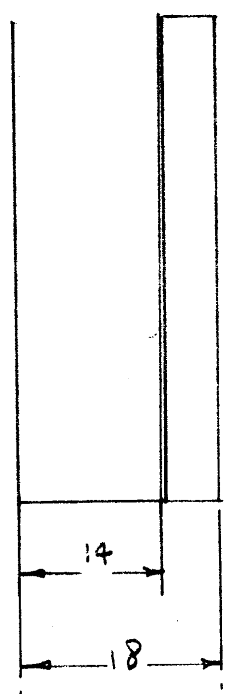

SUGGESTED SECTION THRO' TANK.

EST. PUMP H.P. - 3.

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ASSIGNMENT NO.	STAT
DATE	30 Nov. 1964
PRIORITY	1 STAT
ISSUED BY	

PROCESSOR RESEARCH PROGRAM

DESCRIPTION:	Comprehensive film processing data chart.
STAT SUPERVISING ENGINEER:	
STAFF:	

OBJECTIVE: To compile a chart to list all known aerial and duplicating films and available data and to add to this on a continuing basis, all data obtained as a result of specific tests conducted.

PROPOSED METHOD List the types of aerial or duplicating film by name and number down the left side of chart. Across top, list their characteristics, specular sensitivity, description and special properties, base type, base thickness emulsion and gel-backing thickness, exposure index, resoltuion, granularity also their recommended processing time, temperature and gamma. Fill in appropriate data to correspond with film type, which can be obtained from technical data sheets available in the manual of Physical Properties of Kodak Aerial and Special Sensitized Materials. Design chart to incorporate the results of specific test conducted throughout project.

BRIEFING COMMENTS

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ASSIGNMENT NO.

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1 Dec. 1964

PRIORITY

PROCESSOR RESEARCH PROGRAM

DESCRIPTION: The effects of high processing temperatures on Aerial films.

STAT

SUPERVISING ENGINEER:

STAFF:

OBJECTIVE: To determine the amount of degradation which takes place when film processing temperatures are increased beyond the normal recommended developing parameters and to measure the effect on gamma, speed, fog level, resolution and granularity. The results of these tests will be used as processor design criteria.

PROPOSED METHOD

Control parameters for optimum film processing quality have been established by the manufacturer. Using this as a basis, expose a stop wedge and resolution target on the film being investigated. Increase the processing temperature in 5°F increments to the point where fog level, contrast, resolution, and speed and granularity become degraded. Obtain an acceptable level for film quality, at the highest possible temperature.

BRIEFING COMMENTS

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ASSIGNMENT NO.	[redacted] STAT
	30 Sept. 1964
PRIORITY	
ISSUED BY:	[redacted] STAT

PROCESSOR RESEARCH PROGRAM

DESCRIPTION:	To provide a photographic record of the clean room erection and support area construction progress
SUPERVISING ENGINEER:	[redacted] STAT
STAFF:	
OBJECTIVE:	To insure that a permanent record is obtained of erection and structural details of the clean room and the support facility.

STAT

PROPOSED METHOD

Use Yashica twin lens reflex $2\frac{1}{4}$ camera and equipment on loan from [redacted]
Obtain two prints of each negative.

BRIEFING COMMENTS

STAT

[redacted]

PROCESSOR RESEARCH PROGRAM

ASSIGNMENT NO.	[redacted] STAT
	9 December 1964
PRIORITY	1
ISSUED BY	[redacted] STAT

DESCRIPTION: To determine vertical spacing of liquid bearings.

STAT SUPERVISING ENGINEER: [redacted]

STAFF:

OBJECTIVE: To determine the maximum vertical spacing between liquid bearings of $1\frac{1}{2}$, 1 3/4, and 2 inch diameters.

PROPOSED METHOD

Mock up a minimum of 2 upper rollers and 1 lower roller of the corresponding diameter of a 1 1/2, 1 3/4, and 2 inch diameter bearing plus two (2) cushion heights; i.e. diameter plus 1/8 ins X 2, and vary the height whilst agitating the film, to determine the maximum vertical distance between the upper and lower rollers at which no danger of contact between the sides of the loop will occur.

BRIEFING COMMENTS

If no tank is available, the film may be soaked thoroughly in water and the test made in a free condition.

SUMMARY

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[redacted]

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ASSIGNMENT NO.	
DATE:	19 Oct. 1964
PRIORITY	1
ISSUED BY	

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PROCESSOR RESEARCH PROGRAM

DESCRIPTION: To evaluate performance of possitive pressure transport capstan.

STAT

SUPERVISING ENGINEER:

STAFF:

OBJECTIVE: To test the efficacy of film drive using a positive-pressure capstan versus vacuum, or a combination of both.

PROPOSED METHOD Using completed test stand, hang film over drive capstan with standard weight on one side and spring balance holding back on the other (capstan turns clockwise). Apply vacuum to capstan (actually a blower using the venturi effect to produce suction) and start drive motor.

A. Record

1. Ambient temperature 2. Standard weight (must compensate for weight of spring balance. 3. Static reading of spring balance. Also dead weight of spring balance. 4. Maximum reading of spring balance before slippage.
5. Steady-state reading of spring balance with slippage.
6. RPM of capstan.

B. Repeat, using pressure plenum alone and two blowers.

C. Repeat, using both pressure plenum and vacuum.

D. Tests should include differenet thicknesses of film and leader and different weights.

BRIEFING COMMENTS

Prior to runs, fit pressure plenum with two 1/4" wide gaskets (approx. 1/16" thick) preferably surfaced with thin Teflon tape. Capstan surface should be cleaned with alcohol to remove grease, fingerprints, dust, etc. Be sure holes are not obstructed. Drill wooden shroud at proper spots to support plenum in position with 3/8" bolts and wing nuts. When shroud is remounted, attach to test rack frame using wood screws and old mounting plates. Flexible air hoses should be mounted so as to assure minimum leakage at joints.

STAT

ASSIGNMENT NO.	STAT
	28 Sept. 64
PRIORITY	1
ISSUED BY	

PROCESSOR RESEARCH PROGRAM

DESCRIPTION: To measure the pressure drop across standard P.V.C. fittings.

SUPERVISING ENGINEER: STAT

STAFF:

OBJECTIVE: To design and set up a test rack using PVC piping and a selection of standard P.V.C. elbows, tees, valves, etc., on which can be obtained flow and pressure drops across these fittings.

PROPOSED METHOD

Provide manometer taps at each fitting. Using the cherry burrell pump measure output pressure and flow and take manometer readings at each fitting.

BRIEFING COMMENTS

It was suggested that if shop personnel were to assemble the test rack with no specific precautionary instructions, it would be more representative of field conditions. Subsequent to test, the pipe ends could be faired and a second series of tests made to determine improvement, if any. Stainless steel dairy sanitary plumbing could be tested in a similar fashion. We could also test pump parameters and performance under continued load.

STAT

[redacted]

PROCESSOR RESEARCH PROGRAM

ASSIGNMENT NO.	[redacted] STAT
DATE 11/6/64	2 November 1964
PRIORITY	1
ISSUED BY	[redacted] STAT

DESCRIPTION: Hydromatic Liquid Bearing Assessment

STAT SUPERVISING ENGINEER: [redacted]

STAFF:

OBJECTIVE: To make a complete fluid dynamic investigation of Liquid Bearing configurations, slots versus jets, lifting capacities, fluid flow, efficiencies and design considerations. Build an optimum bearing.

PROPOSED METHOD

Develop a family of curves for bearing performances, varying such parameters as slot size, placement and angle, materials of construction, bearing size and shape, point of feed, etc. Establish, if possible, mathematical relationships and formulae which can be used to predicate optimum design. Compare newly obtained data with archival research performed in the development of the HTA-5.

BRIEFING COMMENTS

It was suggested that a solution could be evolved more rapidly if as many factors as possible affecting the performance characteristics could be held constant while only one was varied. It was felt that an approach untrammeled by prior design would be most productive. Much of the existent pressure-drop Test Rack could be used with minor modifications.

STAT

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ASSIGNMENT NO.	
DATE:	4 December 1964
PRIORITY	1
ISSUED BY	

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PROCESSOR RESEARCH PROGRAM

DESCRIPTION: To determine the coefficient of friction of film.

STAT

SUPERVISING ENGINEER:

STAFF:

OBJECTIVE: To design and construct a floating test rig to enable tests to be conducted to determine the force required to pull $2\frac{1}{2}$ in. wide film through water over a wide range of speeds up to 100 F.P.M. and to develop a formula to apply the results to the design of a LAB Processor.

PROPOSED METHOD

See attached sketch.

BRIEFING COMMENTS

The Force F required to drag a flat plate through water or near water solutions may be calculated from $F = cf \frac{\rho A V^2}{2}$. These tests will determine the values of Cf for film, and enable the above formula to be developed for use in processor design. Other factors required will be such as the bending force required over air and liquid bearings, etc.

SUMMARY

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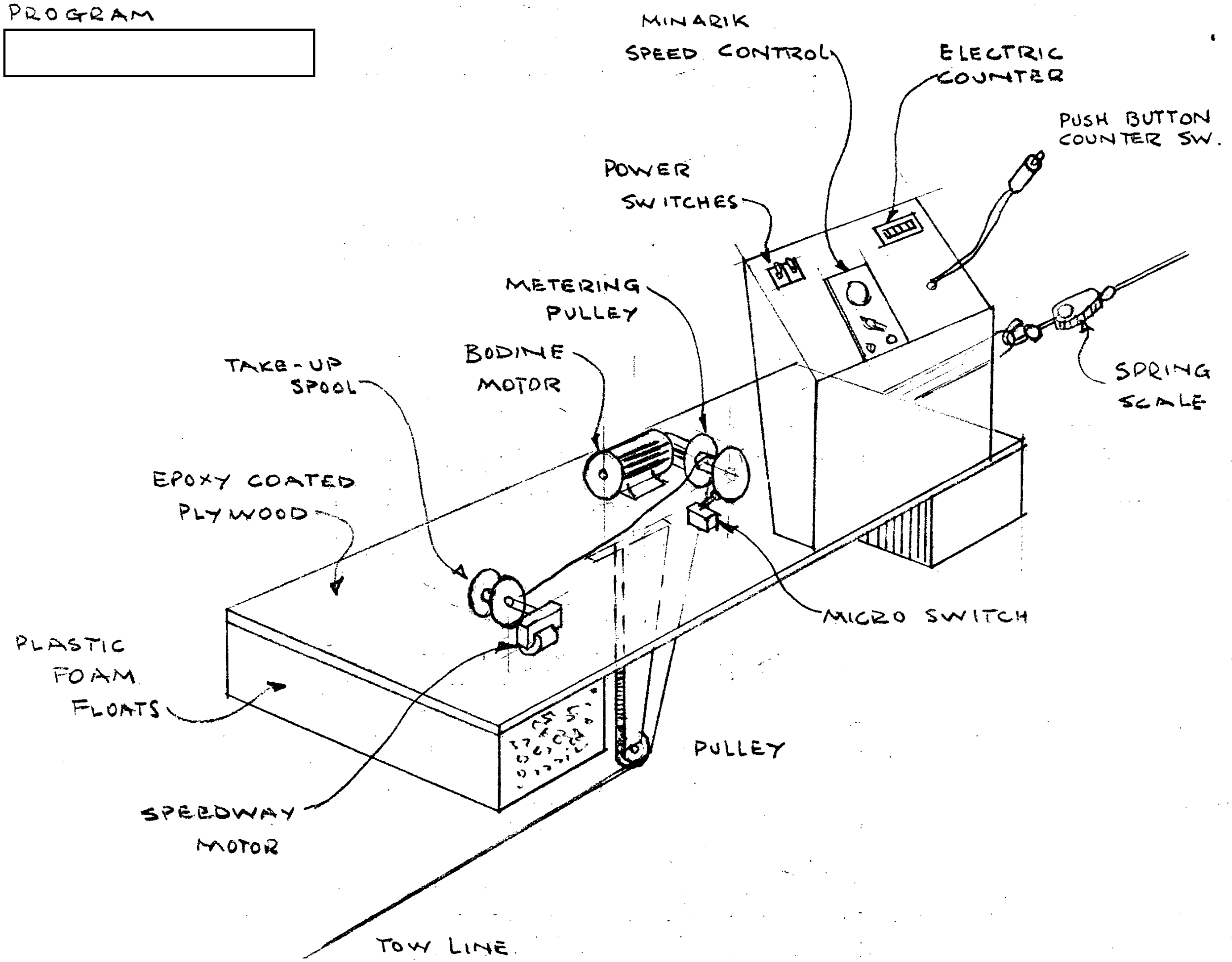
PROCESSOR RESEARCH PROGRAM



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PROGRAM OBJECTIVES

- To install a G.F.E. Clean Room & to Provide a Support Facility
- To provide an Independent Research Group to Implement The Program
- To Improve Processing Techniques & Equipment
  - To Increase Efficience & Reliability
  - To Decrease Maintenance Requirements
  - To Lower Power Requirements
  - To Advance Modular Design
- To Develop The L/A/B Concept of Film Processing
- To Establish Clean Room Operating Parameters for Film Processing
- To Optimize Image Quality

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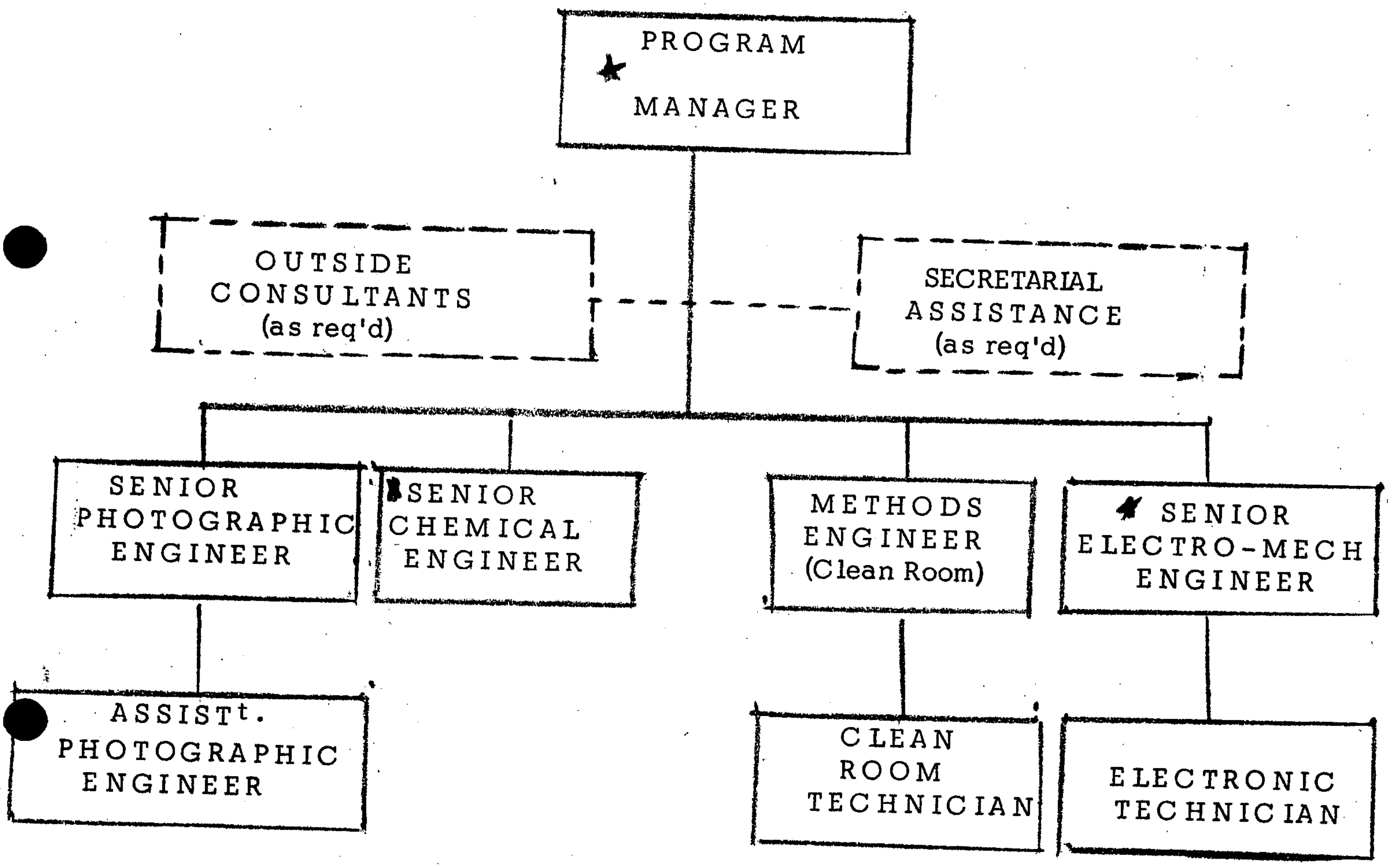
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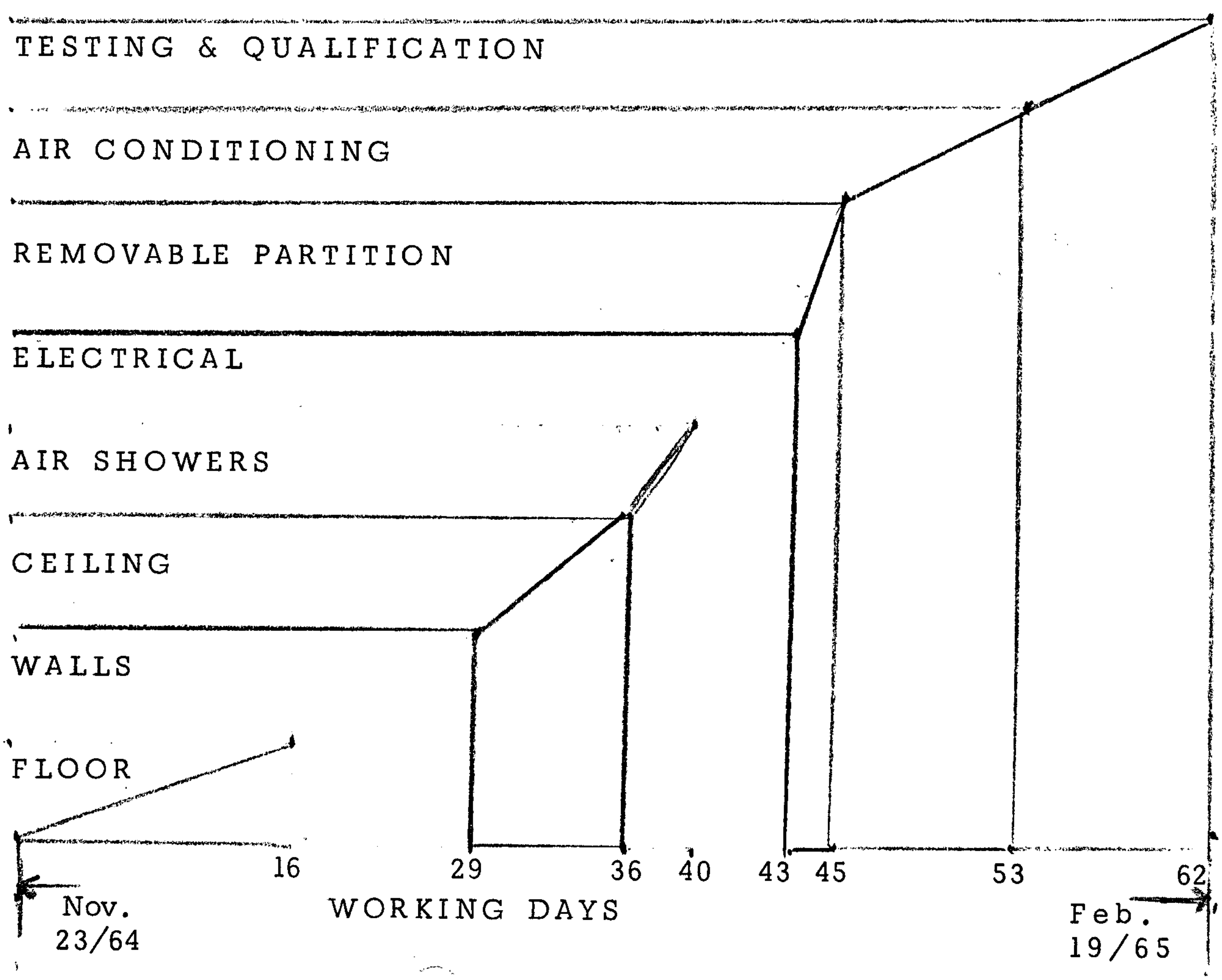
OUTSIDE CONSULTANTS (as req'd)
SECRETARIAL ASSISTANCE (as req'd)
SENIOR PHOTOGRAPHIC ENGINEER
SENIOR CHEMICAL ENGINEER
METHODS ENGINEER (Clean Room)
SENIOR ELECTRO-MECH ENGINEER
ASSISTt. PHOTOGRAPHIC ENGINEER
CLEAN ROOM TECHNICIAN
ELECTRONIC TECHNICIAN

CLEAN ROOM

INSTALLATION SCHEDULE



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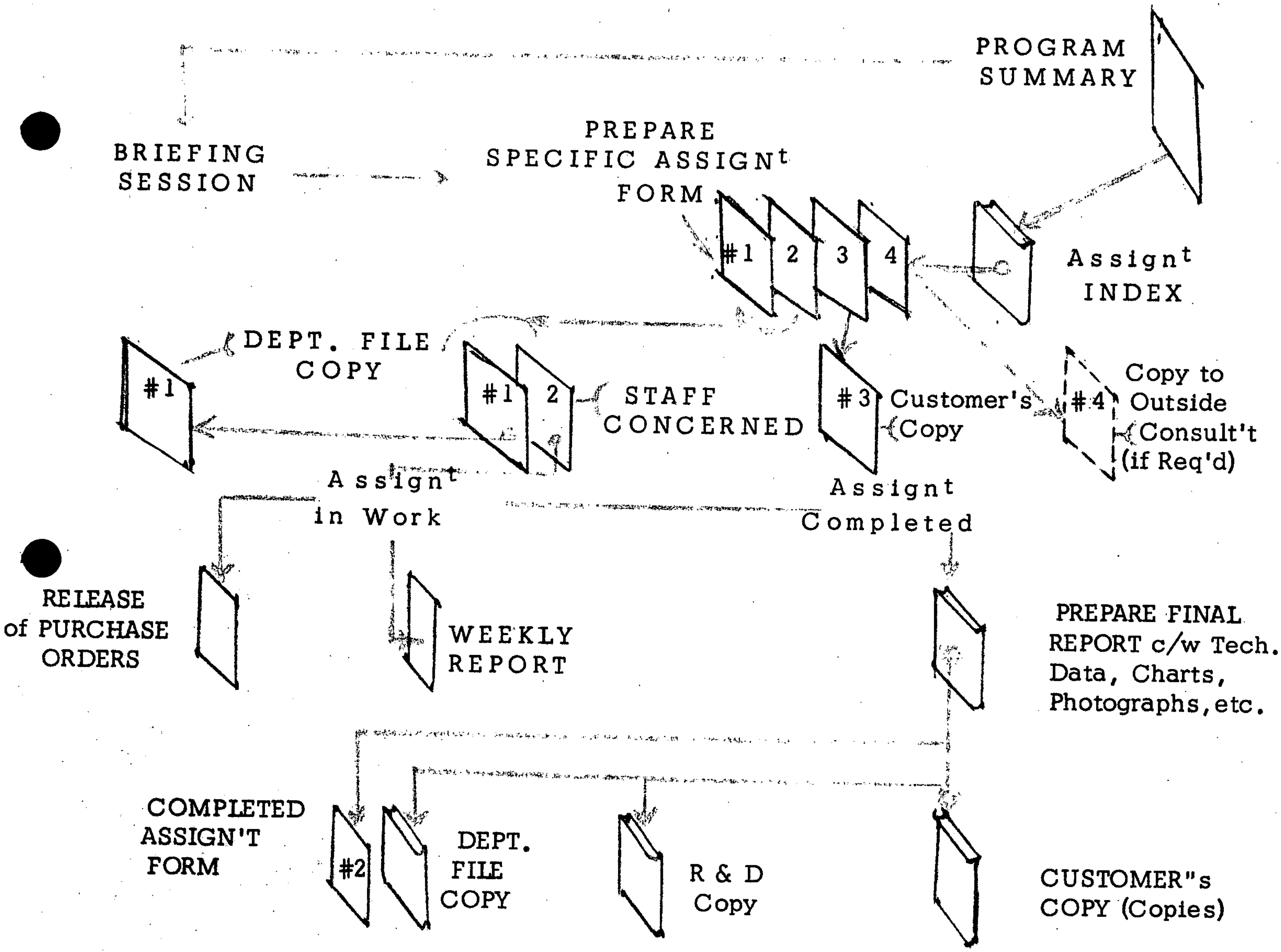
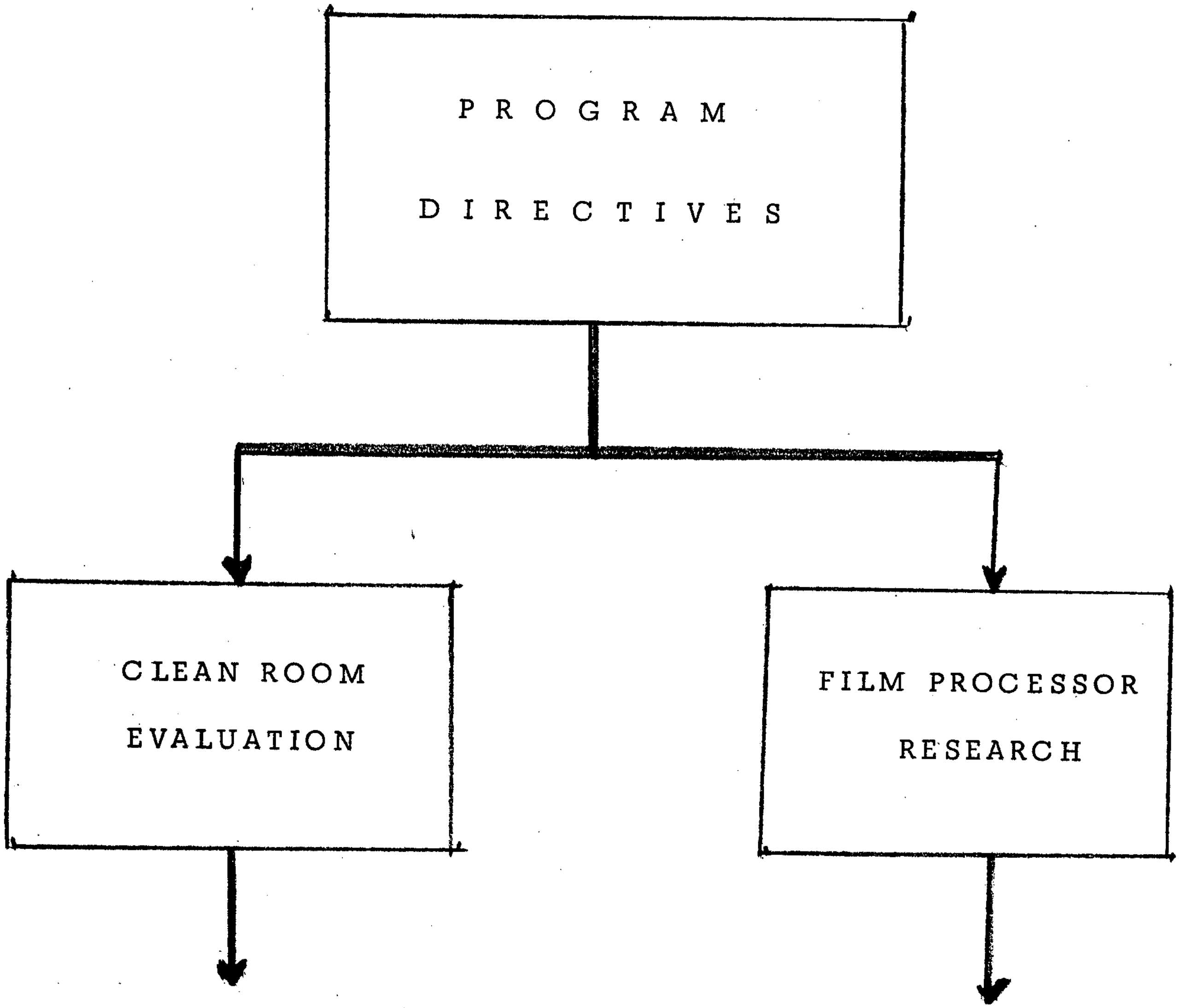
R & D CONTRACT ASSIGNMENT CONTROL

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CLEAN ROOM
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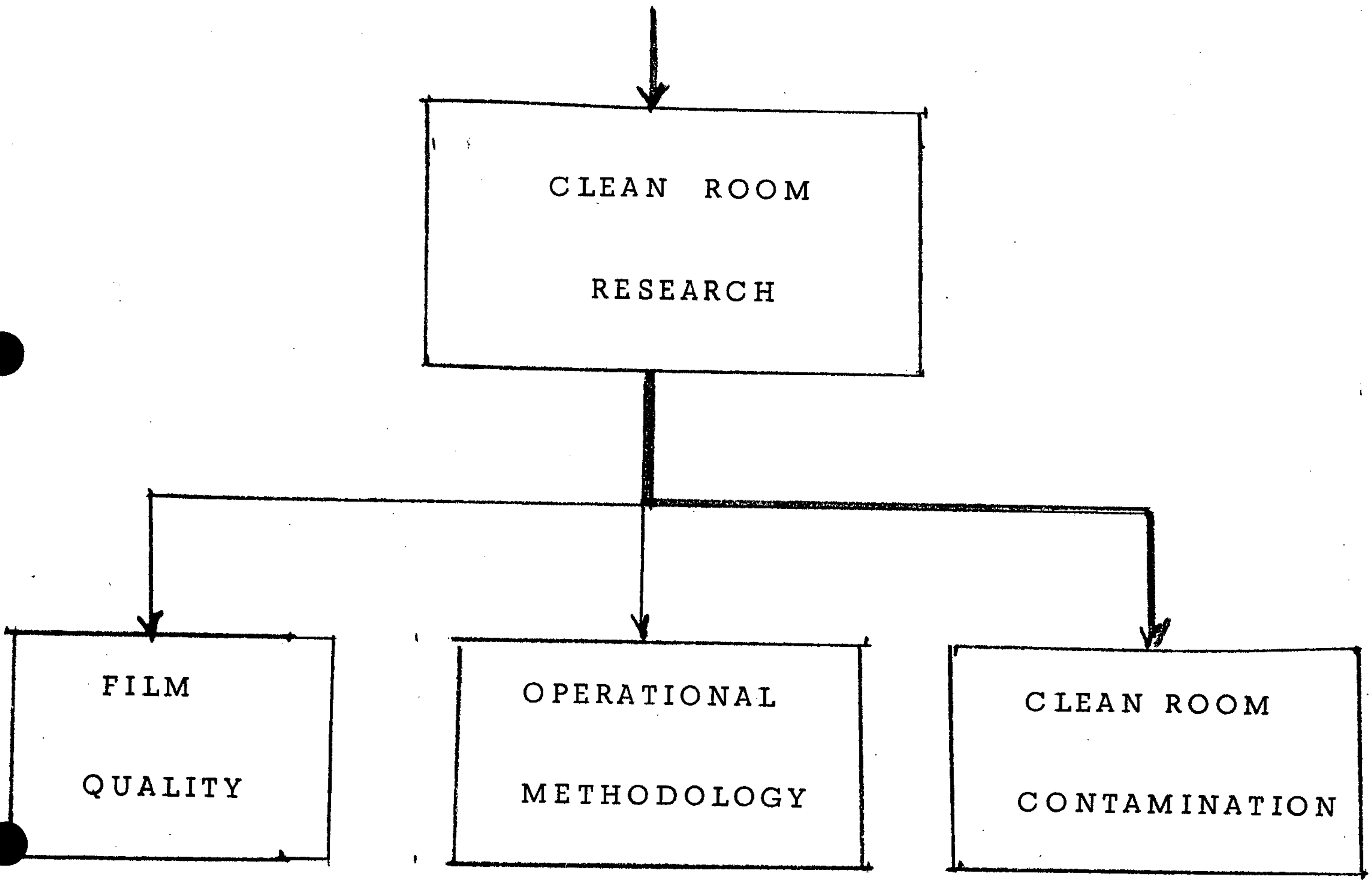
FILM PROCESSOR
RESEARCH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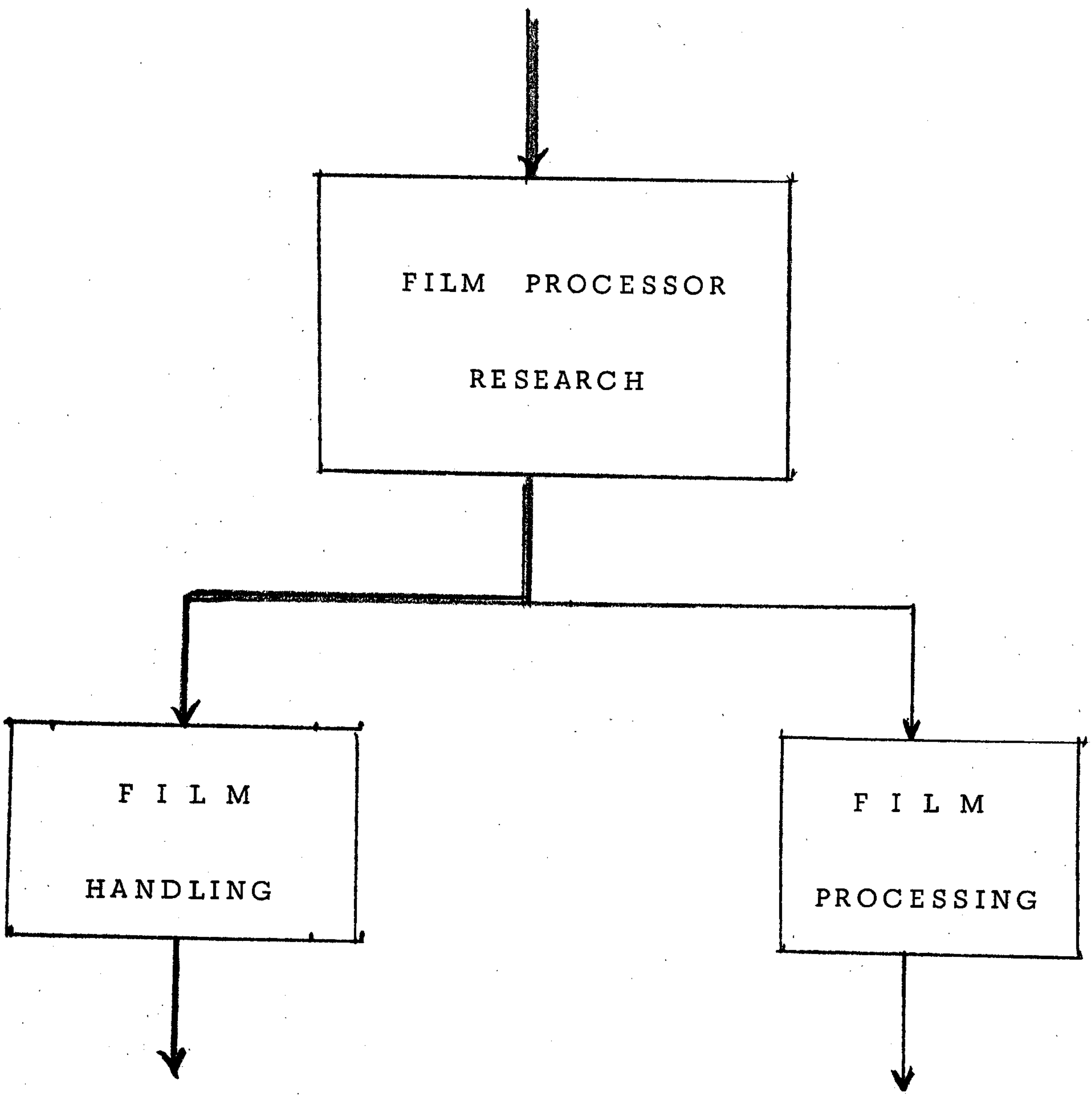
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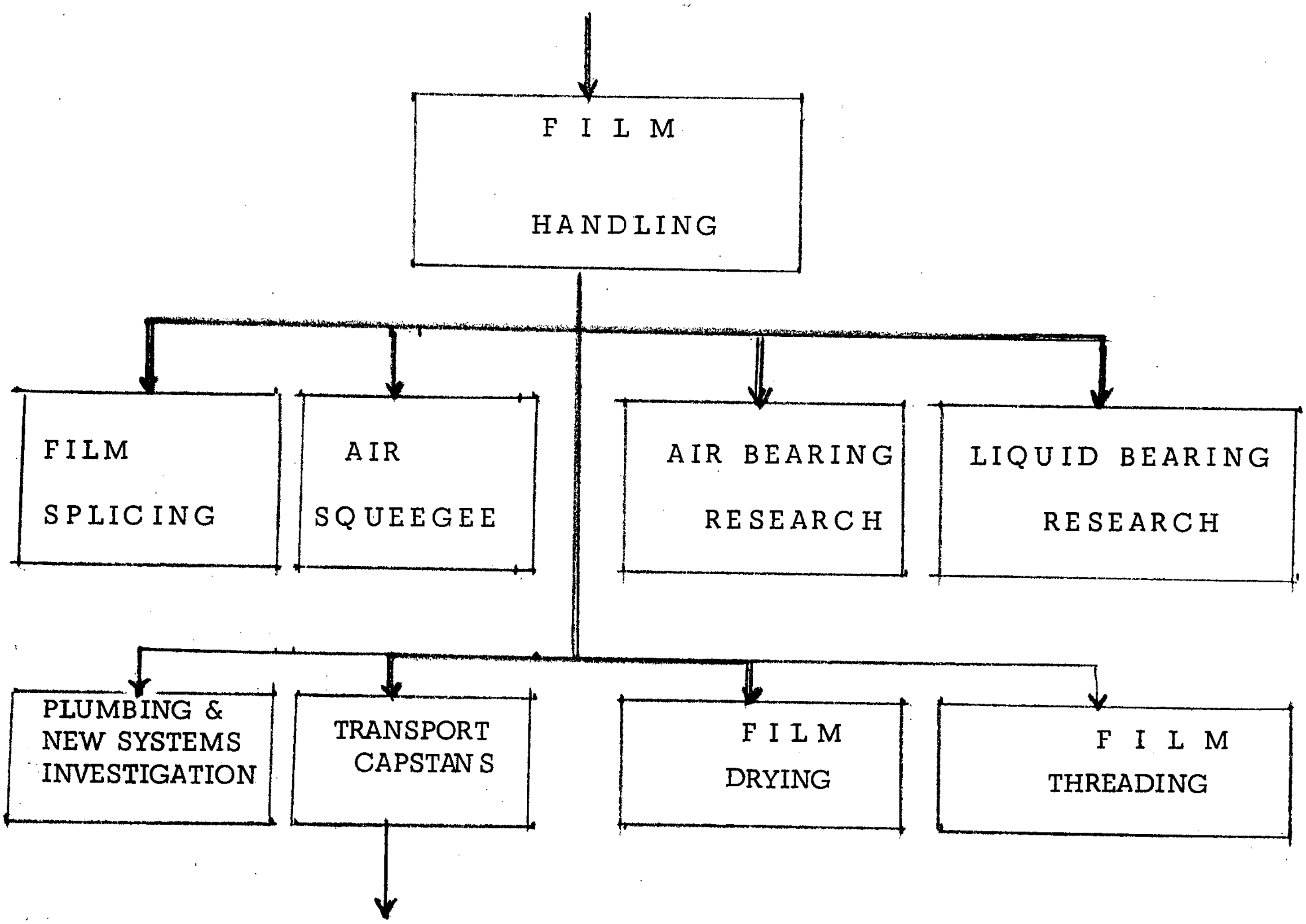
F I L M
PROCESSING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LIQUID BEARING RESEARCH
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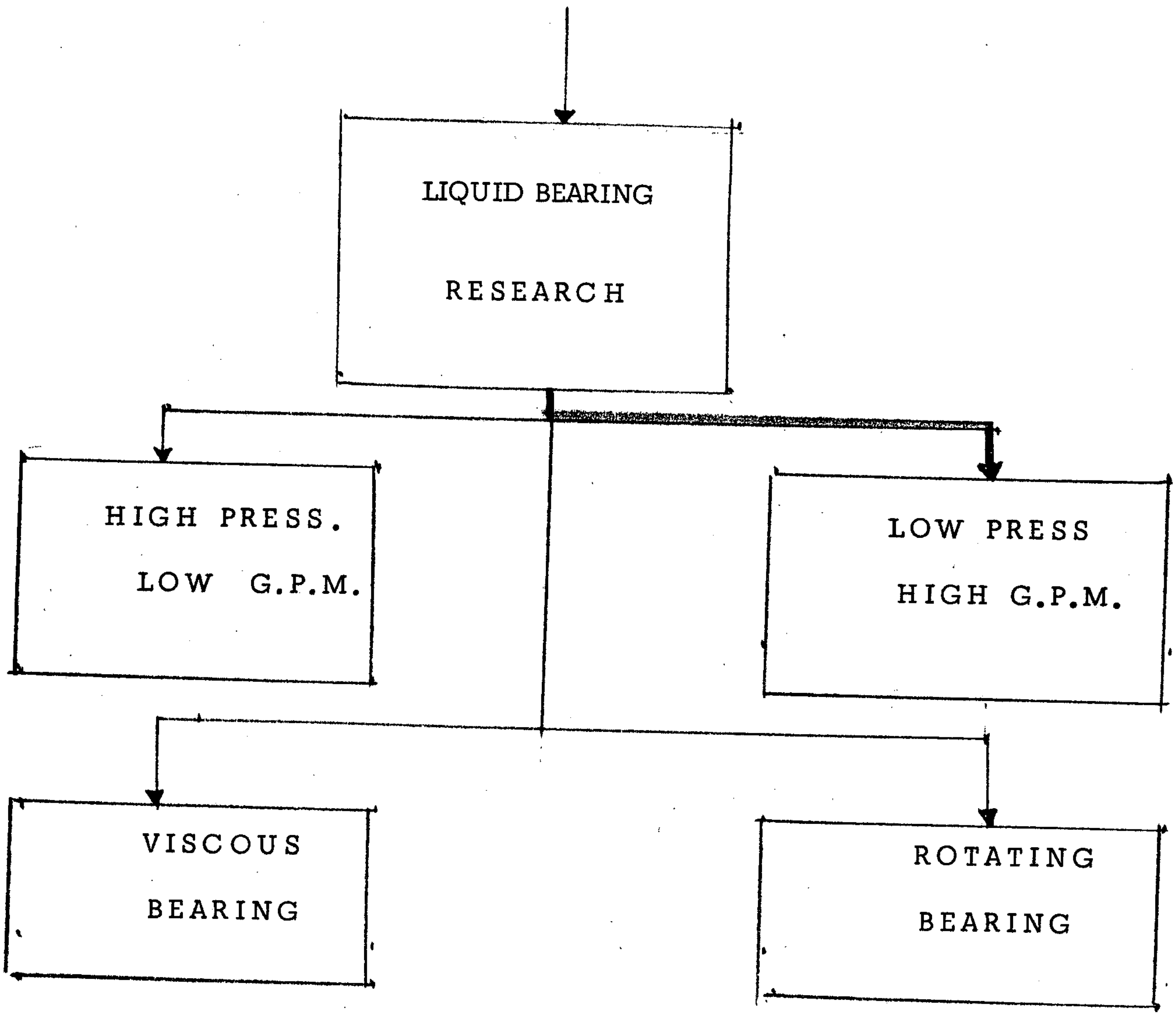
FILM DRYING
FILM THREADING



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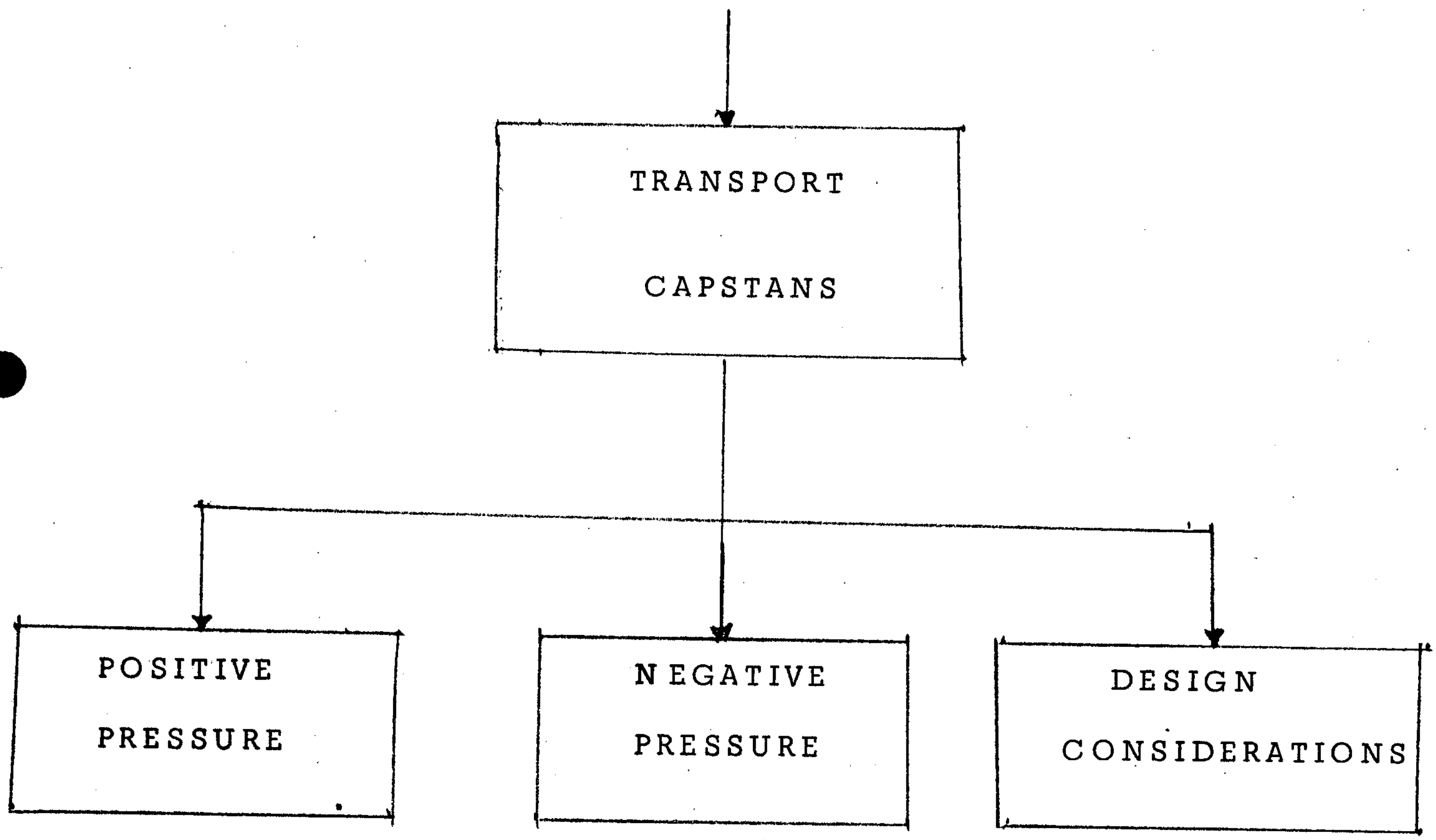
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NEGATIVE PRESSURE
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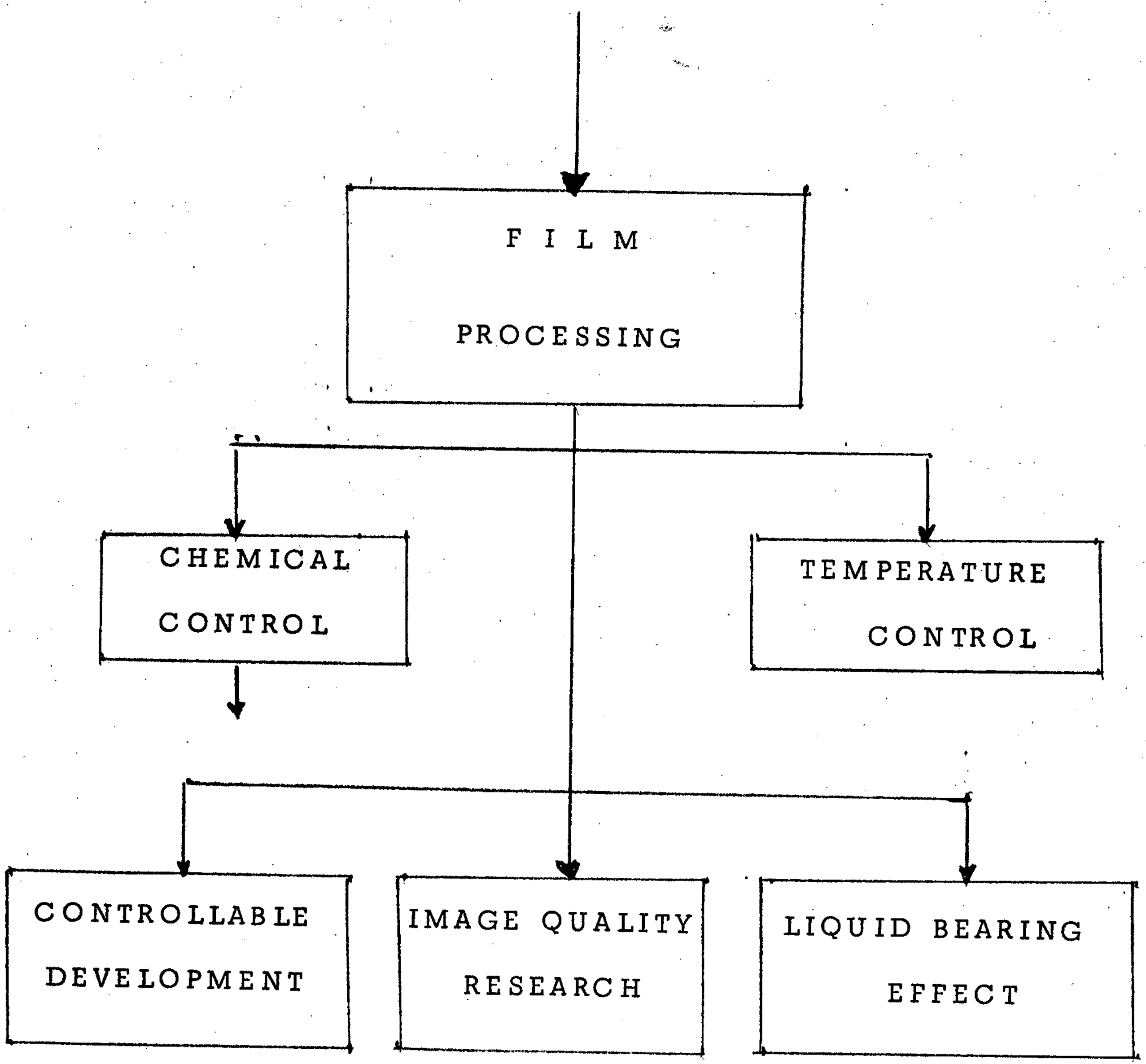
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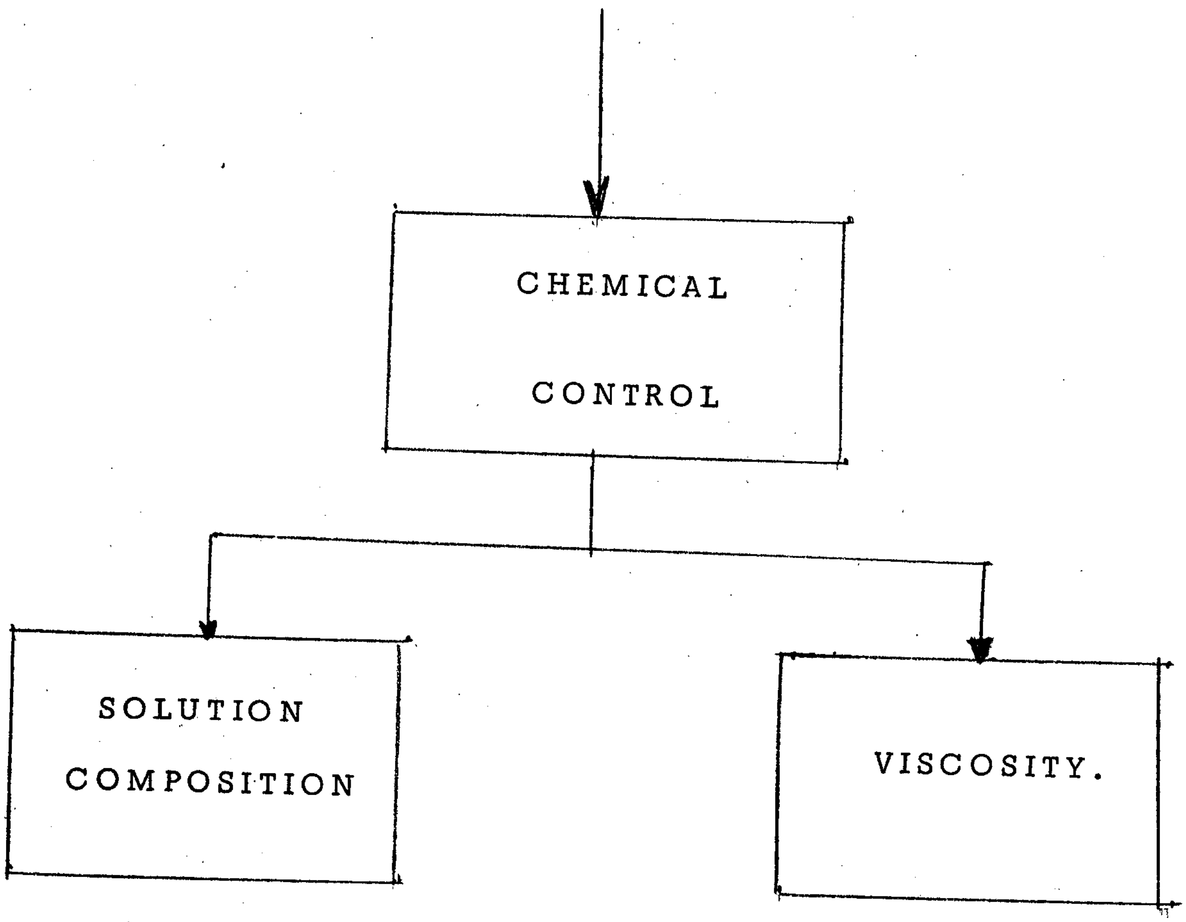
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COMPOSITION
VISCOSITY.